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## (54) A wellhead assembly

(57) A subsea wellhead has an internal tree cap (37) with an isolation sleeve (39) that stabs into a receptacle (41) in the upper end of the tubing hanger (21). The isolation sleeve (39) is sealed in the bore of the tubing hanger (21) by seals (43). To allow displacement of fluid when landing a crown plug (51), or when landing the crown plug internal tree cap together, a vent passage (67) leads through the tubing hanger (21) to a valved passage (76) in the christmas tree (11). In further embodiments the vent passage is replaced by a spring-biased valve in the crown plug (figure 4) or in a combined plug and tree cap (figure 5).

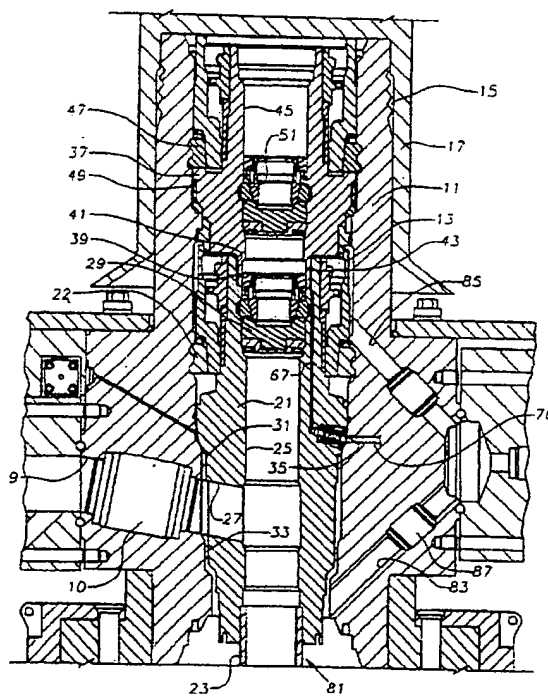


Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

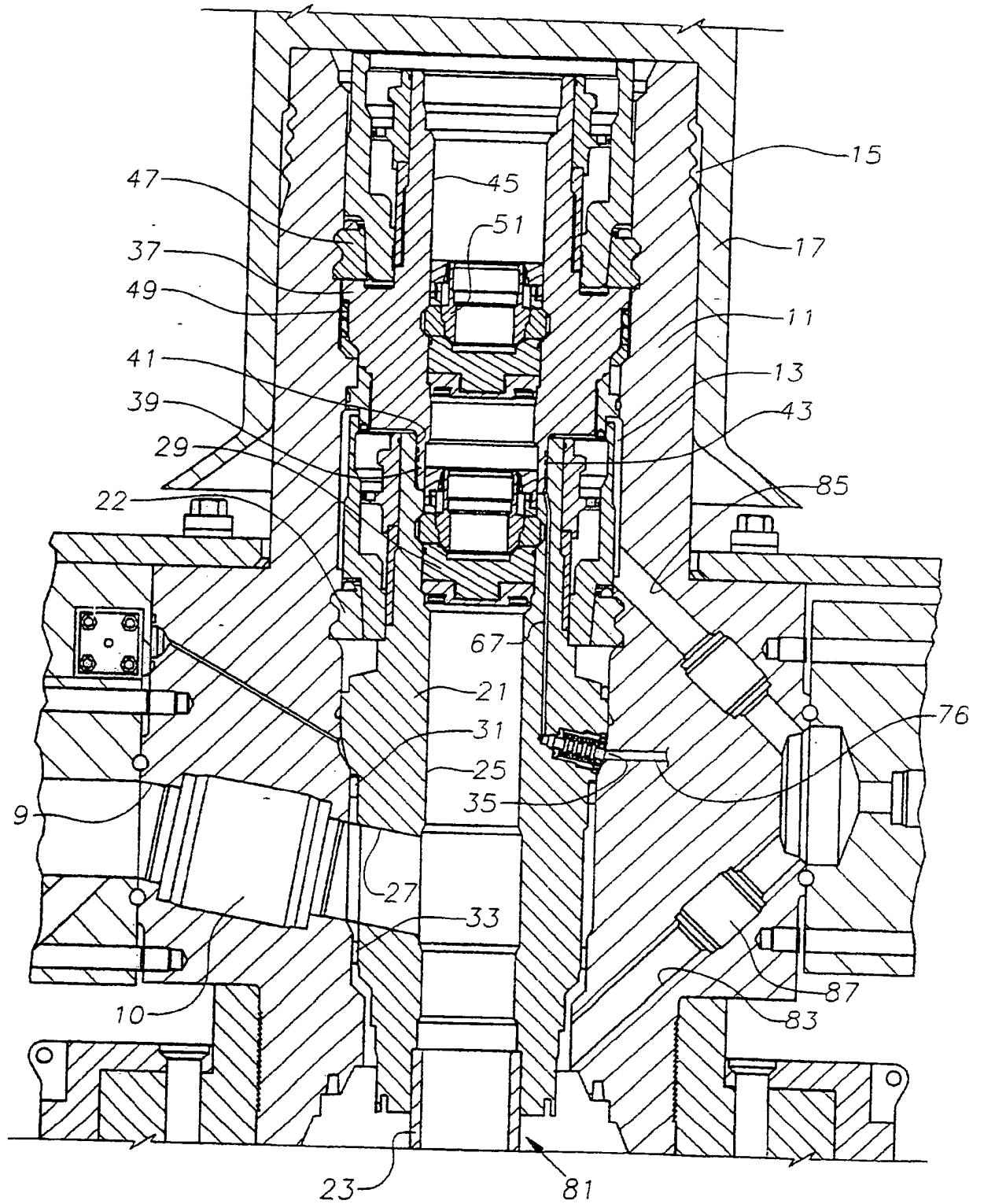
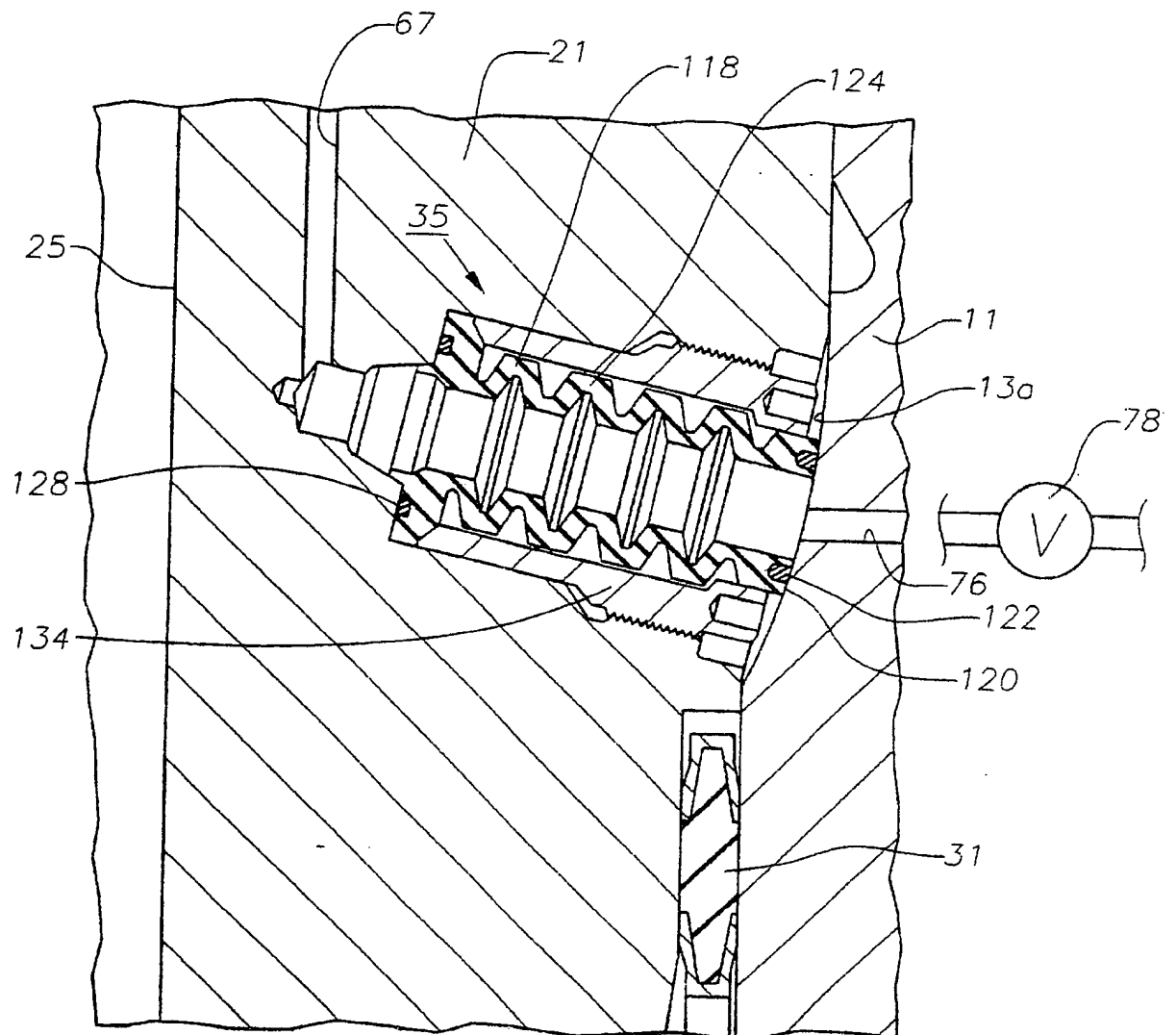


Fig. 1



**Fig. 3**

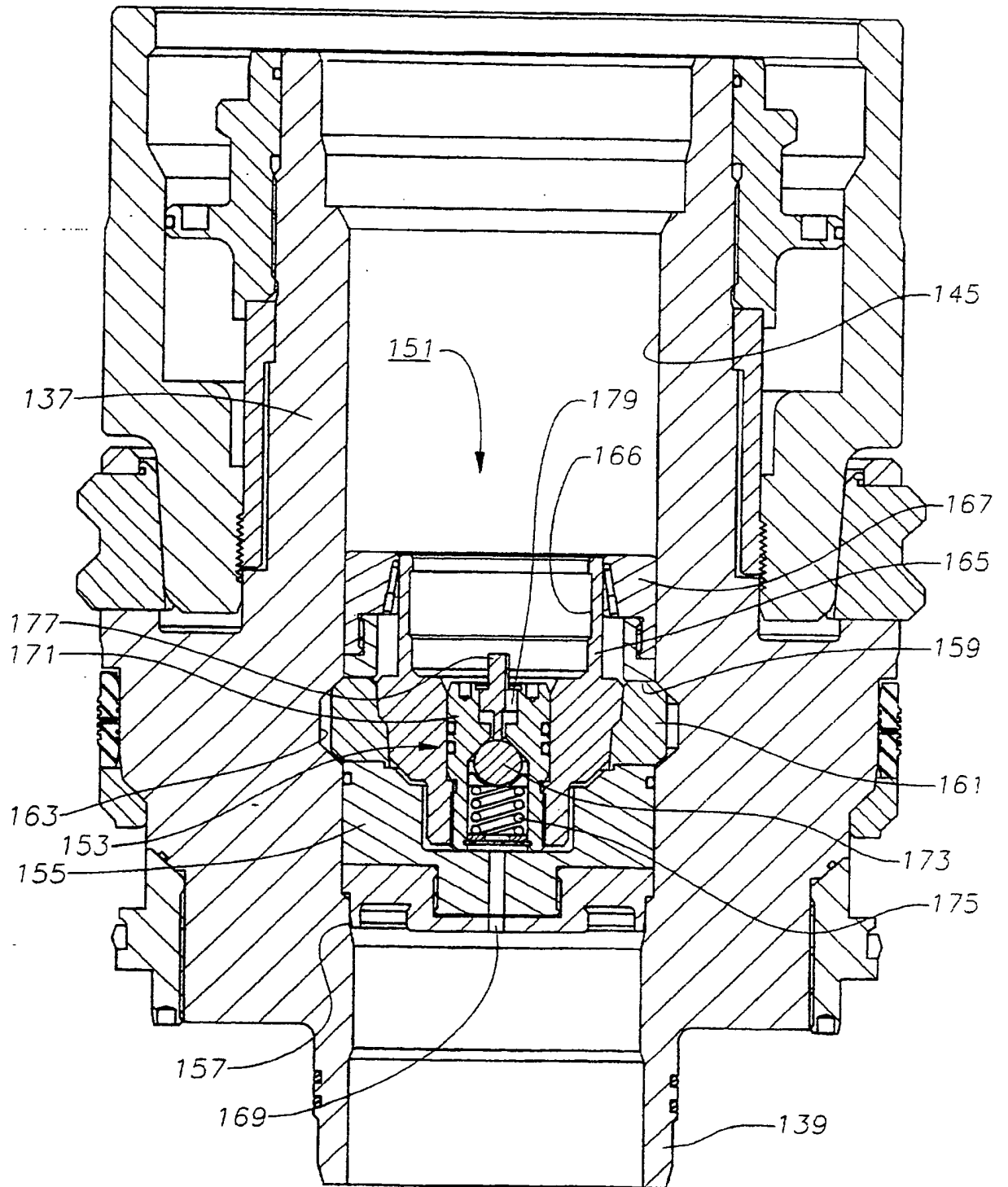


Fig. 4

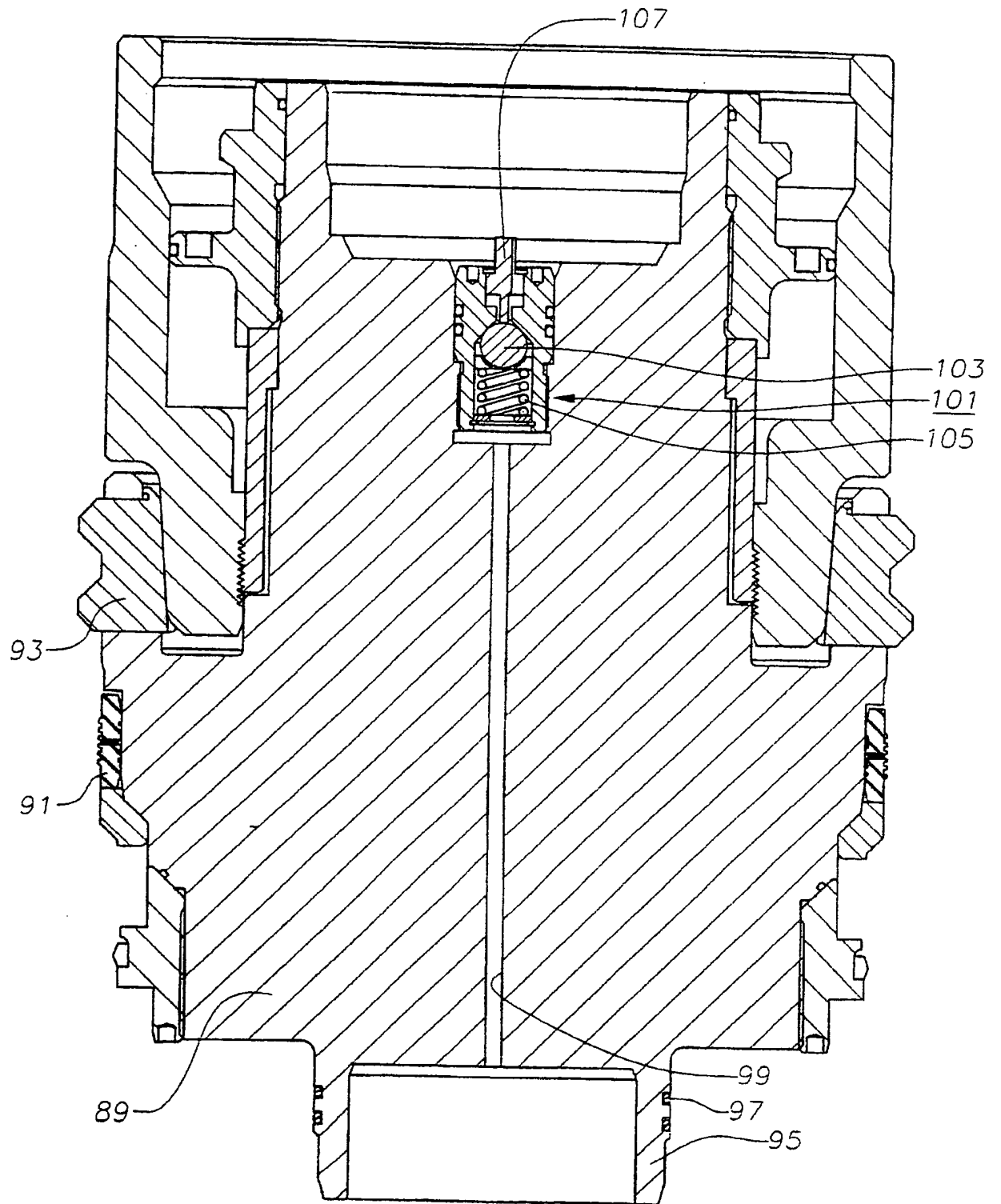


Fig. 5

## TUBING HANGER VENT

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Technical Field

This invention relates in general to oil and gas well christmas trees, and in particular to a tree cap for a horizontal tree.

Background Art

One type of wellhead assembly, particularly used offshore, is known as a horizontal tree. The well has a wellhead housing which contains casing hangers, each secured to a string of production casing that extends into the well. The tree mounts on top of the wellhead housing. The tree has a vertical bore and a horizontal or lateral production flow outlet. A tubing hanger lands in the bore of the tree and is secured to a string of production tubing extending through the casing hangers and into the well. The tubing hanger has a lateral flow passage that registers with the lateral passage of the horizontal tree.

1           A plug, normally wireline retrievable, fits in the  
2           vertical passage of the tubing hanger above the lateral  
3           passage. A tree cap fits above the tubing hanger in the  
4           bore of the tree. The tree cap may have a vertical  
5           passage with a wireline retrievable crown plug or it may  
6           be a solid cap. A corrosion cap fits over the upper end  
7           of the tree.

8           A tubing annulus between the tubing and the casing  
9           communicates to a lower annulus port formed in the tree.  
10          This port leads through an annulus passage to an upper  
11          annulus port which extends into the bore of the tree  
12          above the tubing hanger seals. One or more valves are  
13          used to open and close the tubing annulus. The upper  
14          tubing annulus port communicates with a void that is  
15          located between the tubing hanger wireline plug and the  
16          seal of the internal tree cap. In the prior art,  
17          removing the crown plug from the internal tree cap will  
18          provide a communication between the upper tubing annulus  
19          port and the vertical passage in the internal tree cap.



1        Disclosure of Invention

2            The internal tree cap of this invention has an  
3        isolation sleeve that stabs into a receptacle in the  
4        upper end of the tubing hanger. A seal on the exterior  
5        of the isolation sleeve seals an inner void within the  
6        isolation sleeve from an outer void. The inner void is  
7        the area between the tubing hanger wireline plug and the  
8        tree cap. The outer void is an area surrounding the  
9        tubing hanger above the tubing hanger upper seal and  
10       below the tree cap seal. The internal tree cap may have  
11       a bore and an upper crown plug that is wireline  
12       retrievable.

13           Fluid will be trapped in the inner void when the  
14       isolation sleeve is stabbed into the receptacle above the  
15       tubing hanger. To allow displacement of the fluid when  
16       landing the upper crown plug, or when landing the upper  
17       crown plug and internal tree cap together, a vent passage  
18       leads through the tubing hanger to an external valve.  
19       This vent passage is preferably controlled by a metal  
20       sealing needle valve which is shut by an ROV or diver.

1        Brief Description Drawings

2                Figure 1 is a vertical sectional view of a portion  
3        of a horizontal tree constructed in accordance with this  
4        invention.

5                Figure 2 is an enlarged view of the internal tree  
6        cap of the horizontal tree of Figure 1.

7                Figure 3 is an enlarged view of a seal for the vent  
8        passage of the horizontal tree of Figure 1.

9                Figure 4 is an enlarged sectional view of a second  
10       embodiment of the invention.

11               Figure 5 is an enlarged sectional view of a third  
12       embodiment of the invention.

13  
14        Best Mode for Carrying Out the Invention

15               Referring to Figure 1, christmas tree 11 is of a  
16       type known as a horizontal tree. It has a vertical or  
17       axial tree bore 13 extending completely through it. A  
18       set of grooves 15 are located on the exterior near the  
19       upper end for connection to a drilling riser. A  
20       removable corrosion cover 17 fits over the upper end of  
21       tree 11. Tree 11 has a lateral production passage 19  
22       that extends generally horizontally from bore 13 and is  
23       controlled by a valve 20. Tree 11 will be landed on top

1 of a wellhead housing (not shown) which has casing  
2 extending into a well.

3 A tubing hanger 21 lands sealingly in bore 13.  
4 Tubing hanger 21 is secured to tree 11 by a lock down  
5 mechanism 22. A string of production tubing 23 extends  
6 through the casing hangers (not shown) into the well for  
7 the flow of production fluid. Production tubing 23  
8 communicates with a vertical passage 25 that extends  
9 through tubing hanger 21. A lateral passage 27 extends  
10 from vertical passage 25 and aligns with tree lateral  
11 passage 19.

12 A wireline retrievable plug 29 will lock in vertical  
13 passage 25, sealing the upper end of vertical passage 25.  
14 Tubing hanger 21 has an upper seal 31 located above  
15 lateral passage 27 and a lower seal 33 located below  
16 lateral passage 27. Seals 31, 33 seal to bore 13 of tree  
17 11. A radial port 35 in tubing hanger 21 communicates  
18 with a passage 67 that extends upward through tubing  
19 hanger 21.

20 In the preferred embodiment (Figure 3), a seal  
21 member 118 seals against a spherical sidewall port 13a of  
22 bore 13. Seal member 118 is metal, tubular and located  
23 within port 35. Seal member 118 has a metal seal 120 on

1 its face and elastomeric seals 122, 128 located on its  
2 outer ends. Seal member 118 also has a tubular sidewall  
3 124. A retainer 134 surrounds seal member 118 to hold it  
4 in port 35. A passage 76 leads from port 35 through tree  
5 11 to an outer valve 78 which controls port 35. Outer  
6 valve 78 is a metal sealing needle valve which is  
7 operated by an ROV or a diver after installation when  
8 retrieval operations are complete.

9 Referring to Figures 1 and 2, a tree cap 37 inserts  
10 sealingly into tree bore 13 above tubing hanger 21. Tree  
11 cap 37 has a downward depending isolation sleeve 39 that  
12 is coaxial. Sleeve 39 fits within a receptacle 41 formed  
13 on the upper end of tubing hanger 21. Passage 67  
14 communicates with a vent port 66 located at the interface  
15 between sleeve 39 and receptacle 41. Seals 43 located on  
16 sleeve 39 seal to receptacle 41 above vent port 66. The  
17 interior of sleeve 39 communicates with an axial passage  
18 45 that extends through tree cap 37. Axial passage 45  
19 has approximately the same inner diameter as tubing  
20 hanger passage 25. A locking mechanism 47 similar to  
21 that of the tubing hanger locking mechanism 22 is used to  
22 lock tree cap 37 to tree 11. A seal 49 seals tree cap 37  
23 to tree bore 13.

1           An upper wireline retrievable crown plug 51 inserts  
2           into tree cap passage 45. Referring to Figure 2, crown  
3           plug 51 has a body 53 with a metal seal 55 on its lower  
4           end. Metal seal 55 is a depending lip that engages a  
5           tapered surface in passage 45. Body 53 has a plurality  
6           of windows 57 which allow dogs 59 to extend and retract.  
7           Dogs 59 are pushed outward by a central cam member 61.  
8           Cam member 61 has a profile 63 on its upper end for  
9           engagement by a running tool. Cam member 61 moves  
10          between a lower position shown and an upper position  
11          freeing dogs 59 to retract. A retainer 65 secures to the  
12          upper end of body 53 to retain cam member 61.

13           Referring again to Figure 1, a tubing annulus 81  
14          surrounds tubing 23 between tubing 23 and the smallest  
15          diameter string of casing (not shown). Tubing annulus 81  
16          communicates with a lower annulus passage 83 that extends  
17          from tree bore 13 through the wall of tree 11 below  
18          tubing hanger seal 33. Lower annulus passage 83  
19          communicates with an upper annulus passage 85 that  
20          extends into tree bore 13 above tubing hanger seal 31 and  
21          below tree cap seal 49. Valves 87 are located in annulus  
22          passages 83, 85.

1           In operation, after the well has been drilled and  
2           cased, the operator lowers tree 11 onto the wellhead  
3           housing (not shown). The operator then may install  
4           production tubing 23. Tubing hanger 21 lands in bore 13  
5           with its passage 27 aligning with horizontal passage 19.  
6           Wireline plug 29 may be installed with a wireline tool.

7           Wireline plug 51 will be installed and tested in  
8           tree cap 37 at the rig. Then, tree cap 37 is lowered on  
9           a string of conduit, such as drill pipe. Isolation  
10          sleeve 39 will stab into receptacle 41 as locking  
11          mechanism 47 locks tree cap 37 to bore 13. Excess fluid  
12          trapped between plugs 29, 51 may flow out vent passage  
13          67, through radial port 35, passage 76 and valve 78.

14          For a workover operation in which tubing 23 needs to  
15          be pulled, a drilling riser can be employed. After  
16          removal of corrosion cap 17, the operator installs a  
17          drilling riser to profile 15, the drilling riser having  
18          a blowout preventer (not shown). The operator will lower  
19          a drill string into engagement with tree cap 37 and  
20          retrieve it. After pulling internal tree cap 37, the  
21          operator may circulate a kill fluid to kill the well.

22          To do so, the operator installs an inner riser  
23          string (not shown) which stabs into receptacle 41 of

1 tubing hanger 21. Pipe rams (not shown) in the drilling  
2 riser are closed around the inner riser string. Upper  
3 tubing annulus passage 85 now communicates with an  
4 annulus surrounding the inner riser, which in turn  
5 communicates with choke and kill lines leading alongside  
6 the riser back to the drilling rig. The operator will  
7 pull wireline plug 29 with a wireline tool. A port (not  
8 shown) at the lower end of tubing 23 will be opened to  
9 communicate the interior of tubing 23 with tubing annulus  
10 81. This may be done with a wireline tool in a  
11 conventional manner. With production valve 20 closed and  
12 tubing annulus valve 87 open, the operator can pump down  
13 the inner riser, down tubing 23 and back up tubing  
14 annulus 81. The annulus fluid circulates through annulus  
15 passages 83, 85, up tree bore 13 and through the choke  
16 and kill lines to the surface. After the kill fluid has  
17 been placed in the well, the operator may pull production  
18 tubing 23.

19 Under some circumstances, an operator may wish to  
20 achieve wireline intervention into tubing 23 without  
21 killing the well and without using the drilling riser.  
22 Wireline access is achievable with the well under flowing  
23 conditions. A wireline riser (not shown) will be

installed in the upper portion of passage 45 of tree cap  
37. The operator can use a wireline tool to engage crown  
plug 51. The operator will retrieve plugs 51, 29 in a  
conventional manner to perform the wireline intervention.  
Plugs 51, 29 may be reinstalled conventionally. Vent  
port 67 avoids hydraulic lock when landing plug 51.

Referring to Figure 4, a second embodiment of the  
invention is shown. A wireline retrievable crown plug  
151 inserts into a tree cap passage 145 in an internal  
tree cap 137. Crown plug 151 has a vent check valve 153  
that when opened will allow pressure from below to vent  
upward above check valve 153. Check valve 153 has a body  
155 which has a metal seal 157 secured to its lower end.  
Seal 157 is a depending lip that seals against a tapered  
surface formed in tree cap passage 145. Body 155 has a  
plurality of windows 159 which allows dogs 161 to  
protrude through. When in the outer locked position,  
dogs 161 will engage a groove 163 in tree cap passage 45.  
A cam member 165 is carried reciprocally within body 155.  
When in the lower position, cam member 165 keeps dogs 161  
in the outer locked position. When cam member 165 is  
pulled upward, it will allow dogs 161 to retract from  
groove 163. Cam member 165 has a profile 166 on its



1 upper end to allow engagement of a running and retrieval  
2 tool (not shown). A retainer 167 secures to the upper  
3 end of body 155 to retain cam member 165. A vent port  
4 169 extends axially through body 155 to the lower end of  
5 cam member 165.

6 Check valve 153 is located within a cavity in cam  
7 member 165. Check valve 153 includes a valve body 171  
8 carried within an axial cavity in cam member 165. A ball  
9 173 is urged upward by a spring 175 against a seat for  
10 blocking any flow from below. A plunger 177 extends  
11 upward from valve body 171. Plunger 177 can be stroked  
12 downward by the running tool, and moves upward in  
13 response to the force of spring 175. When stroked  
14 downward from the position shown, it pushes ball 173  
15 downward, allowing upward flow past the seat. Plunger  
16 177 has a flow channel 179 to allow flow of fluid in an  
17 upward direction when it is pushed downward.

18 Preferably, crown plug 151 will be installed in tree  
19 cap 37 and pressure tested while tree cap 137 is at the  
20 drilling rig. Tree cap 137 will be lowered on a running  
21 tool on drill pipe. Check valve 153 will be held in an  
22 open position while isolation sleeve 139 stabs into a  
23 receptacle (not shown). Preferably this is handled by a

1 mechanical device on the lower end of the running tool  
2 (not shown). The open position of check valve 153 allows  
3 displacement of trapped fluid between wireline plugs 29,  
4 151. The fluid flows up vent passage 169 and through  
5 check valve 153 into tree cap passage 45 above crown plug  
6 151. After installation and testing, the running tool is  
7 retrieved, causing check valve 153 to close due to the  
8 force of spring 175. Check valve 153 serves as a second  
9 pressure barrier to the wireline plug in the tubing  
10 hanger.

11 For a workover operation requiring the pulling of  
12 tubing 23 (Figure 1), the operator may use a drilling  
13 riser and blowout preventer stack (not shown). Normally,  
14 a kill fluid will be circulated into the well which is  
15 heavier than the well fluid to prevent a blowout. The  
16 operator will land a running tool on internal tree cap  
17 37, which at the same time depresses plunger 177 to vent  
18 any pressure buildup in an inner void 188 between the two  
19 wireline plugs 29, 151. This will inform the operator  
20 whether or not the tubing hanger wireline plug had been  
21 leaking.

22 The operator then pulls internal tree cap 37 and  
23 runs back in with an inner riser string (not shown) which

1 stabs into the receptacle of the tubing hanger. Pipe  
2 rams (not shown) in the drilling riser are closed around  
3 the inner riser string. Upper tubing annulus passage 85  
4 (Figure 1) now communicates with an annulus surrounding  
5 the inner riser, which in turn communicates with choke  
6 and kill lines leading alongside the riser back to the  
7 drilling rig. The operator will pull wireline plug 29  
8 (Figure 1) with a wireline tool. A port (not shown) at  
9 the lower end of tubing 23 will be opened to communicate  
10 the interior of tubing 23 with tubing annulus 81. This  
11 may be done with a wireline tool in a conventional  
12 manner. With production valve 20 (Figure 1) closed and  
13 tubing annulus valve 87 open, the operator can pump down  
14 the inner riser, down tubing 23 and back up tubing  
15 annulus 81. The annulus fluid circulates through annulus  
16 passages 83, 85, up tree bore 13 and through the choke  
17 and kill lines to the surface. After the kill fluid has  
18 been placed in the well, the operator may pull production  
19 tubing 23.

20 Under some circumstances, an operator may wish to  
21 achieve wireline intervention into tubing 23 without  
22 killing the well and without using the drilling riser.  
23 Wireline access is achievable with the well under flowing

1 conditions. A wireline riser (not shown) will be  
2 installed in the upper portion of passage 145 of tree cap  
3 137. The operator can use a wireline tool to engage  
4 crown plug 151. Check valve 153 will be opened to vent  
5 off any pressure buildup that might exist in inner void  
6 188 between tubing hanger wireline plug 29 and crown plug  
7 151. The operator will retrieve plugs 151, 29 in a  
8 conventional manner to perform the wireline intervention.  
9 When reinstalling crown plug 151, check valve 153 will be  
10 opened to allow displacement of trapped fluid in inner  
11 void 188.

12 A third embodiment is shown in Figure 5. In this  
13 embodiment, there is no wireline plug, such as crown plug  
14 151 contained within tree cap 137 (Figure 4). Instead,  
15 tree cap 89 is a solid plug having no means for allowing  
16 wireline intervention. Tree cap 89 has a seal 91 that  
17 seals to bore 13. A locking mechanism 93 will lock tree  
18 cap 89 to tree 11. Tree cap 89 has an isolation sleeve  
19 95 that extends into receptacle 41 of tubing hanger 21.  
20 Sleeve 95 has seals 97 for sealing to receptacle 41.

21 A vent passage 99 extends through tree cap 89 along  
22 its axis. Vent passage 99 is a small passage, not  
23 sufficiently large to accommodate a crown plug such as

1 crown plug 51. A check valve 101 is mounted to the upper  
2 end of vent passage 99. Check valve 101 is similar to  
3 check valve 153. It has a ball 103 which is urged upward  
4 by a spring 105 against a seat. A plunger 107 operated  
5 by a running tool will depress ball 103 to allow venting  
6 of trapped fluid during installation of tree cap 89.

7 The invention has several advantages. The vent port  
8 vents fluid from the inner void when landing the upper  
9 crown plug, or when landing the upper crown plug and  
10 internal tree cap together. The vent port also admits  
11 fluid to the void when retrieving the upper crown plug  
12 and/or the internal tree cap, thus preventing a vacuum  
13 from being formed. In addition, the vent port detects  
14 and/or vents build-up pressure in the region due to a  
15 leakage in the lower plug. Finally, the vent port  
16 permits a pressure test to be carried out on the seals of  
17 the upper crown plug and the stab sub of the internal  
18 tree cap. The vent port allows separate pressure  
19 monitoring of the tubing annulus from the crown plug.

20 While the invention has been shown in only three of  
21 its forms, it should be apparent to those skilled in the  
22 art that it is not so limited, but is susceptible to

1           various changes without departing from the scope of the  
2           invention.

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1       I claim:

2       1.    A wellhead assembly, comprising in combination:

3           a christmas tree having an axial bore and a lateral  
4       production passage;

5           a tubing hanger landed in the bore of the tree and  
6       having a lateral opening that aligns with the lateral  
7       production passage in the tree and an axial bore;

8           a retrievable plug landed in the bore of the tubing  
9       hanger above the lateral opening;

10          an internal tree cap assembly landed in the bore of  
11       the tree above the tubing hanger, the tree cap assembly  
12       having a downward depending isolation sleeve which  
13       extends into the bore of the tubing hanger;

14          a seal on the isolation sleeve which seals in the  
15       bore of the tubing hanger, creating a void between the  
16       plug and the internal tree cap; and

17          a vent passage leading from the void for avoiding  
18       fluid lock in the void between the plug and the tree cap  
19       assembly when the tree cap assembly is landed in the bore  
20       of the tree.

21  
22       2.    The wellhead assembly of claim 1, further comprising  
23       a valve for opening and closing the vent passage.

1           3.    The wellhead assembly of claim 1, further comprising  
2           a check valve in the vent port which prevents flow from  
3           the void when in a closed position and allows flow from  
4           the passage when in an open position.

5  
6           4.    The wellhead assembly of claim 1 wherein the vent  
7           passage is in the tree cap assembly.

8  
9           5.    The wellhead assembly of claim 1 wherein the vent  
10          passage extends through the tubing hanger and christmas  
11          tree to an exterior.

12  
13          6.    The wellhead assembly of claim 1, further  
14          comprising:

15                an axial bore in the tree cap assembly; and

16                a second retrievable plug landed in the bore of the  
17          tree cap assembly.

18  
19          7.    The wellhead assembly of claim 1, further  
20          comprising:

21                an axial bore in the tree cap assembly;



1           a second retrievable plug landed in the bore of the  
2           tree cap assembly; and wherein the vent passage is in the  
3           second plug and further comprising

4           a check valve in the vent passage in the second  
5           plug for allowing trapped fluid to be expelled above the  
6           second plug when the check valve is in an open position.

7  
8           8. The wellhead assembly of claim 1 wherein the vent  
9           passage leads axially through the tree cap assembly; and  
10          further comprising

11          a check valve in the vent passage for releasing  
12          fluid trapped between the tree cap and the plug when the  
13          check valve is in an open position.

14  
15          9. In a wellhead assembly having a christmas tree with  
16          an axial bore, a lateral production passage, and a tubing  
17          hanger landed in the bore of the tree, the tubing hanger  
18          having an axial bore and a lateral opening that aligns  
19          with the lateral production passage in the tree, the  
20          improvement comprising:

21          a first retrievable plug landed in the bore of the  
22          tubing hanger above the lateral opening;

1           an internal tree cap assembly landed in the bore of  
2       the tree above the tubing hanger, the tree cap assembly  
3       having an axial bore and a downward depending isolation  
4       sleeve which extends into the bore of the tubing hanger;

5           a seal on the isolation sleeve which seals in the  
6       bore of the tubing hanger, creating a void between the  
7       first plug and the internal tree cap;

8           a second retrievable plug landed in the bore of the  
9       tree cap assembly;

10          a vent passage communicating with the void for  
11       expelling fluid trapped between the plugs when the tree  
12       cap assembly is landed in the bore of the tree; and

13          a valve for opening and closing the vent passage.

14  
15       10. The wellhead assembly of claim 9 wherein the vent  
16       passage is in the second plug and wherein the valve is a  
17       check valve that allows fluid to be expelled from the  
18       void when moved to an open position.

19  
20       11. The wellhead assembly of claim 9 wherein the vent  
21       passage extends through the tree cap assembly.

1        12. The wellhead assembly of claim 9 wherein the vent  
2        passage extends through the tubing hanger and the tree to  
3        an exterior.

4  
5        13. The wellhead assembly of claim 9 wherein the vent  
6        passage leads axially through the tree cap assembly and  
7        the valve is a check valve that allows fluid to be  
8        expelled from the void when moved to an open position.

9  
10       14. A wellhead assembly, comprising in combination:  
11       a christmas tree having an axial bore and a lateral  
12       production passage;

13       a tubing hanger landed in the bore of the tree and  
14       having a lateral opening that aligns with the lateral  
15       production passage in the tree and an axial bore;

16       a first retrievable plug landed in the bore of the  
17       tubing hanger above the lateral opening;

18       an internal tree cap landed in the bore of the tree  
19       above the tubing hanger, the tree cap having a downward  
20       depending isolation sleeve which extends sealingly into  
21       the bore of the tubing hanger creating a void between the  
22       tree cap and the first plug;

1           a check valve in the tree cap in communication with  
2           the void and adapted to be held in an open position when  
3           the tree cap is landed in the bore of the tree so that  
4           fluid may be released from the void to avoid fluid lock.

5  
6           15. The wellhead assembly of claim 14 wherein the tree  
7           cap has a bore; and further comprising

8           a second retrievable plug located in the bore of the  
9           tree cap; and wherein

10           the check valve is located within the second plug.

11  
12           16. The wellhead assembly of claim 14 wherein the tree  
13           cap is solid and has an axial passage; and wherein

14           the check valve is located in the axial passage of  
15           the tree cap, the axial passage communicating with the  
16           check valve and the void.

17  
18           17. The wellhead assembly of claim 14 wherein the check  
19           valve further comprises:

20           a valve body having a flow channel and a seat;

21           a spring;

22           a ball which is urged upward by the spring against  
23           the seat for blocking fluid from the void;

1           a plunger which moves upward in response to the  
2           spring; and

3           means for urging the plunger downward so that fluid  
4           may be released through the flow channel from the void  
5           when the tree cap is landed in the bore of the tree.  
6

7           18. In a wellhead assembly having a christmas tree with  
8           an axial bore, a lateral production passage, and a tubing  
9           hanger landed in the bore of the tree, the tubing hanger  
10          having an axial bore and a lateral opening that aligns  
11          with the lateral production passage in the tree, the  
12          improvement comprising:

13               a first retrievable plug landed in the bore of the  
14               tubing hanger above the lateral opening;

15               an internal tree cap assembly landed in the bore of  
16               the tree above the tubing hanger, the tree cap assembly  
17               having an axial bore and a downward depending isolation  
18               sleeve which extends into the bore of the tubing hanger;

19               a seal on the isolation sleeve which seals in the  
20               bore of the tubing hanger, creating a void between the  
21               first plug and the internal tree cap;

22               a second retrievable plug landed in the bore of the  
23               tree cap assembly;

1           a vent passage leading through the tubing hanger  
2           between the isolation sleeve and the tubing hanger to an  
3           exterior of the tree for expelling fluid trapped between  
4           the plugs when the tree cap assembly is landed in the  
5           bore of the tree; and

6           a valve for opening and closing the vent passage.  
7

8           19. A method for avoiding fluid lock in a wellhead  
9           assembly, comprising:

10           (a) providing a christmas tree having an axial bore  
11           and a lateral production passage;

12           (b) landing a tubing hanger in the bore of the  
13           tree, the tubing hanger having a lateral opening that  
14           aligns with the lateral production passage in the tree  
15           and an axial bore;

16           (c) landing a retrievable plug in the bore of the  
17           tubing hanger above the lateral opening;

18           (d) landing an internal tree cap assembly in the  
19           bore of the tree above the tubing hanger, the tree cap  
20           assembly having a downward depending isolation sleeve  
21           which extends into the bore of the tubing hanger;

1           (e) sealing the isolation sleeve with a seal in the  
2 bore of the tubing hanger, creating a void between the  
3 plug and the internal tree cap; and then

4           (f) releasing fluid trapped in the void through a  
5 vent port for avoiding fluid lock in the void between the  
6 plug and the tree cap assembly when the tree cap assembly  
7 is landed in the bore of the tree.

8  
9           20. The method of claim 19 wherein step (f) comprises  
10 releasing fluid through the vent port to an exterior of  
11 the tree.

12  
13           21. The method of claim 19 wherein step (f) comprises  
14 releasing fluid through the vent port and into a vent  
15 passage in the tree cap assembly.

16  
17           22. The method of claim 19 wherein step (f) comprises  
18 releasing fluid through the vent port and into a vent  
19 passage in the tubing hanger.

20  
21           23. A method for avoiding fluid lock in a wellhead  
22 assembly, comprising:

1           (a) providing a christmas tree having an axial bore  
2           and a lateral production passage;

3           (b) landing a tubing hanger in the bore of the  
4           tree, the tubing hanger having a lateral opening that  
5           aligns with the lateral production passage in the tree  
6           and an axial bore;

7           (c) landing a first retrievable plug in the bore of  
8           the tubing hanger above the lateral opening;

9           (d) landing an internal tree cap assembly in the  
10          bore of the tree above the tubing hanger, the tree cap  
11          assembly having a downward depending isolation sleeve  
12          which extends into the bore of the tubing hanger;

13          (e) landing a second retrievable plug in the bore  
14          of the tree cap assembly;

15          (f) sealing the isolation sleeve with a seal in the  
16          bore of the tubing hanger, creating a void between the  
17          plugs; and then

18          (g) releasing fluid trapped in the void through a  
19          vent port for avoiding fluid lock in the void between the  
20          plugs when the tree cap assembly is landed in the bore of  
21          the tree.



1        24. The method of claim 23 wherein step (g) comprises  
2        releasing fluid through the vent port and into a vent  
3        passage having a valve.

4  
5        25. The method of claim 23 wherein step (g) comprises  
6        releasing fluid through the vent port and into a vent  
7        passage in the tree cap assembly.

8  
9        26. The method of claim 23 wherein step (g) comprises  
10       releasing fluid through the vent port and into a vent  
11       passage in the tubing hanger.

12  
13       27. A method for avoiding fluid lock in a wellhead  
14       assembly, comprising:

15            (a) providing a christmas tree having an axial bore  
16       and a lateral production passage;

17            (b) landing a tubing hanger in the bore of the  
18       tree, the tubing hanger having a lateral opening that  
19       aligns with the lateral production passage in the tree  
20       and an axial bore;

21            (c) landing a retrievable plug in the bore of the  
22       tubing hanger above the lateral opening;

1           (d) landing an internal tree cap assembly in the  
2 bore of the tree above the tubing hanger, the tree cap  
3 assembly having a downward depending isolation sleeve  
4 which extends into the bore of the tubing hanger;

5           (e) sealing the isolation sleeve with a seal in the  
6 bore of the tubing hanger, creating a void between the  
7 plug and the internal tree cap; and

8           (f) providing a check valve in the tree cap  
9 assembly for avoiding fluid lock in the void between the  
10 plug and the tree cap assembly when the tree cap assembly  
11 is landed in the bore of the tree; and then

12           (g) opening the check valve so that fluid may be  
13 released from the void.  
14



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Claims searched: 1-27

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Date of search: 17 April 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1F: FJB, FJC, FJR

Int Cl (Ed.6): E21B: 33/03, 33/04, 33/043

Other: Online WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.